Low Cost, High-G, MEMS IMU Coordinated Development for Common Guidance

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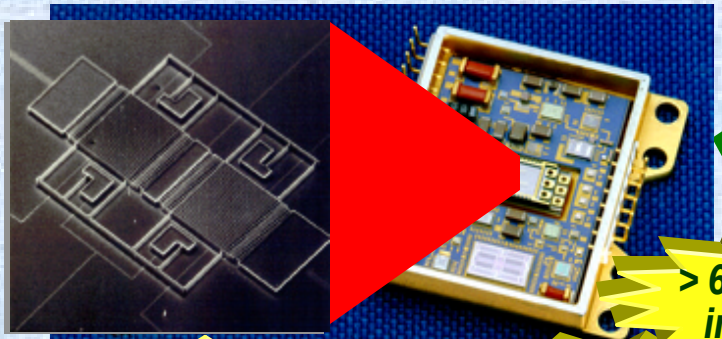
19 JUNE 2002

7th International Artillery & Indirect Fire Symposium

MEMS-IMU/GPS Military Applications For Tactical Engagements

- **Purpose:** To develop affordable and reliable MEMS accelerometers and gyros for IMUs / INSs for DoD Munitions, Missiles, Soldiers, Vehicles, and Aircraft
- **Objective:** Develop manufacturing technology for affordable, high-g, Precision IMU and IMU/GPS
- **Approach:** An Army managed / Navy/AF supported effort that will achieve economy of scale and have industry competition



System Insertions

Tactical Grade MEMS-IMU/GPS

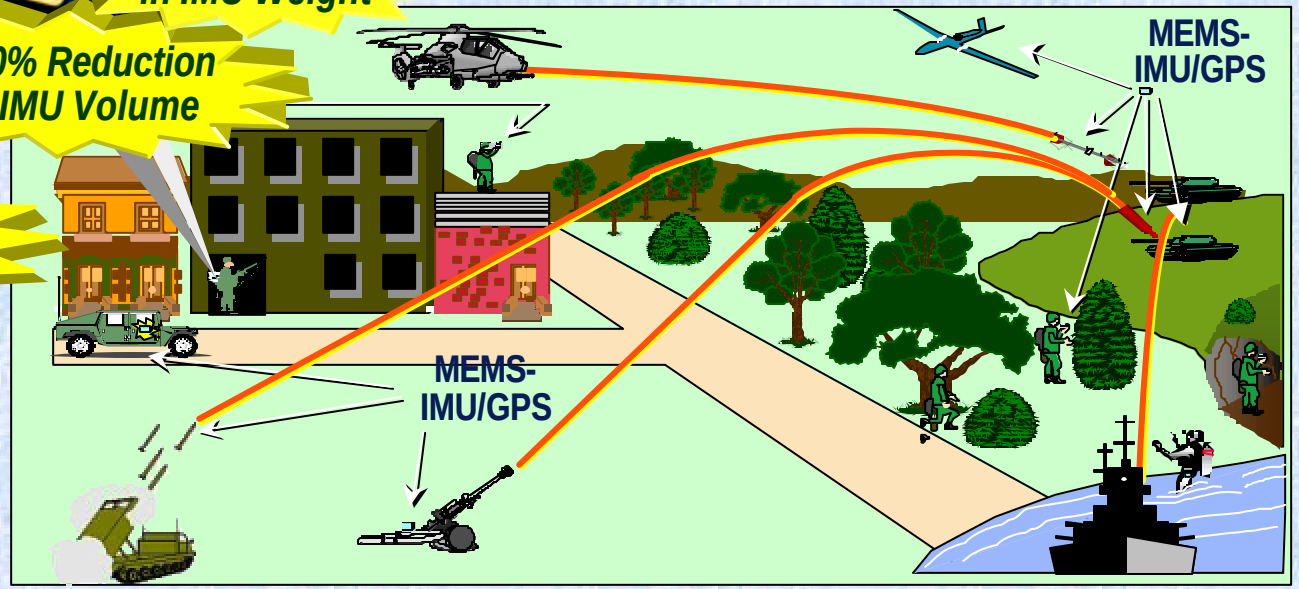
- $1200 IMU / $1500 IMU-GPS
- 1.0°/hr Gyro Drift Rate
- < 500 mg Accelerometer Bias
- Temperature Range: -54 to 85°C
- Low Power < 2 Watts
- Small Size: < 3 cu inch
- High-g Hardening (> 20,000 g)

> 66% Reduction in IMU Weight

> 80% Reduction in Power Rqmts

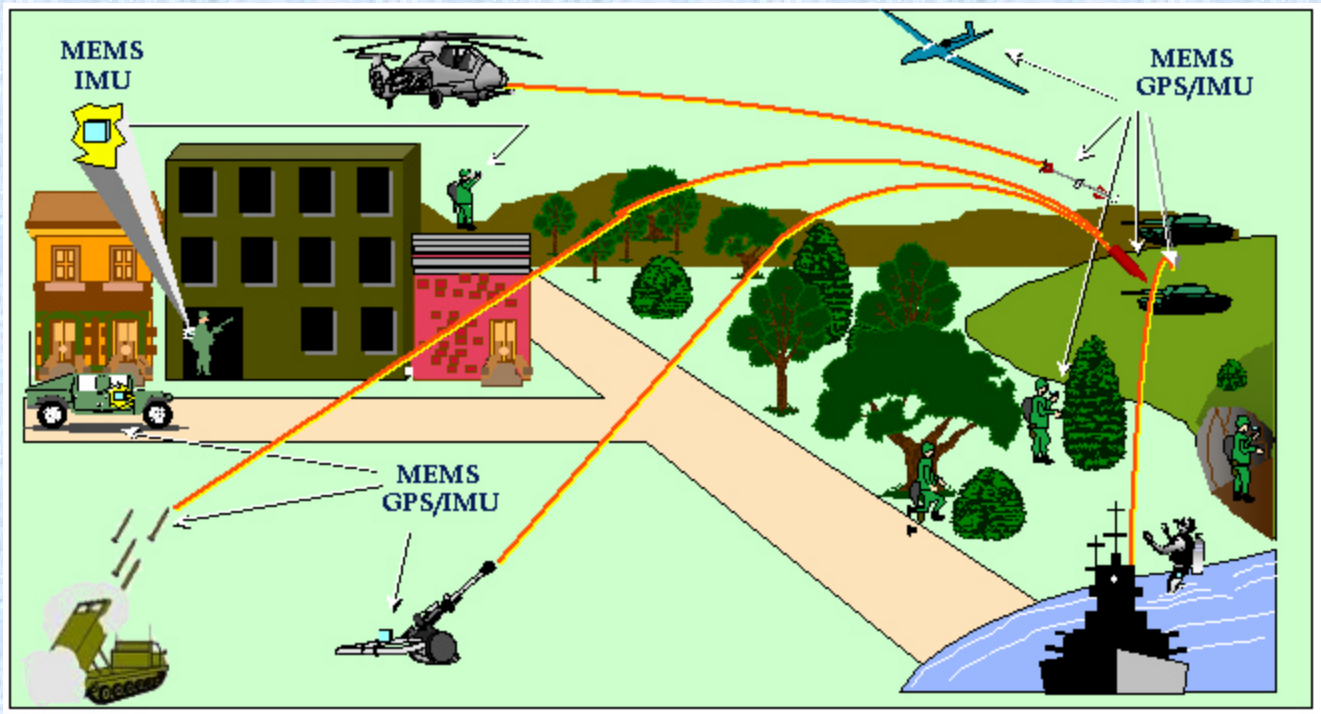
> 90% Reduction in IMU Volume

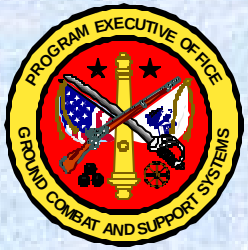
>80% Reduction in Cost ($1.2K / IMU)



COST SHARING:
66% BY Gov't
33% BY INDUSTRY

Affordable and Reliable Inertial Measurement Units (IMUs)





New Capabilities in Precision Strike and Navigation
... Enabled by Micro-Electro-Mechanical-System (MEMS)

Low Cost, High-g MEMS-IMU/GPS …for Precision Strike

Technology & Manufacturing Development

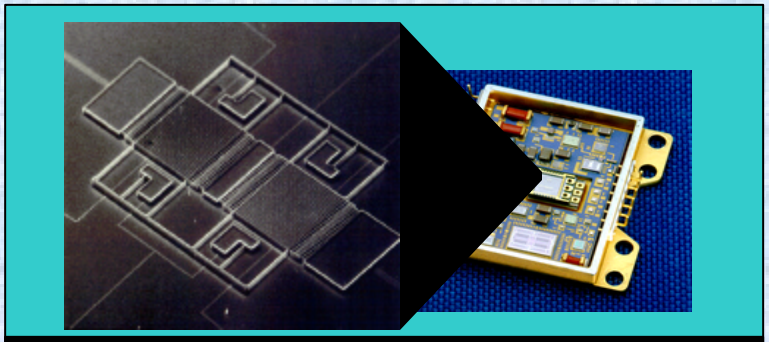
FY01 FY02 FY03 FY04 FY05 FY06

- **> 90% Reduction in IMU Volume**
- **>80% Reduction in Cost ($1.5K per GPS/IMU)**
- **>66% Reduction in IMU Weight**
- **>80% Reduction in Power Rqmts**

Honeywell HG-1700

Weight:	*2*	*lbs*
Volume:	*33*	*cu in*
Power:	*< 8*	*Watts*
Bias Stability:	*1*	*deg/hr*
Shock:	*10 - 100*	*g*

Economy of Scale

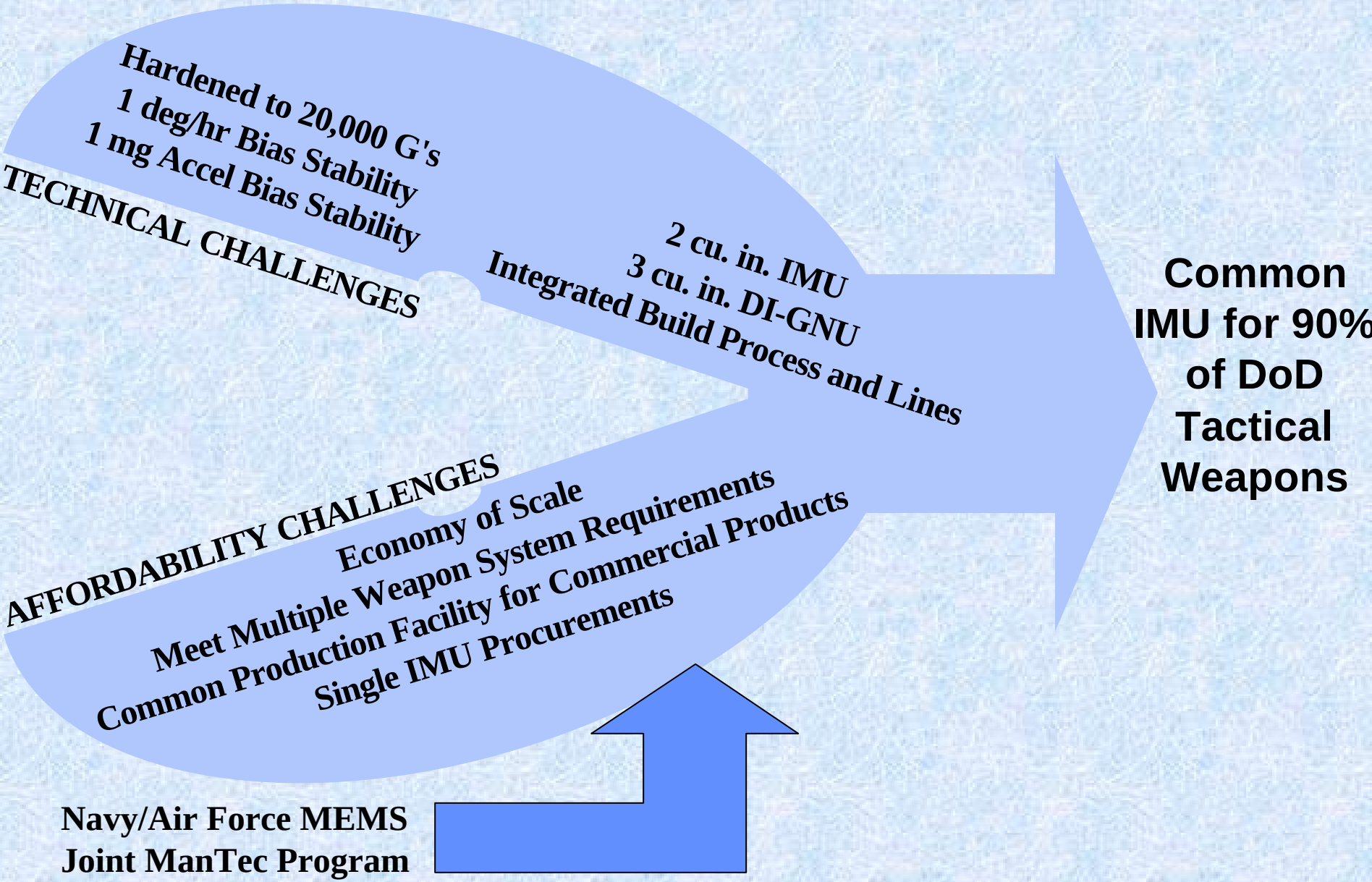


MEMS-IMU/GPS

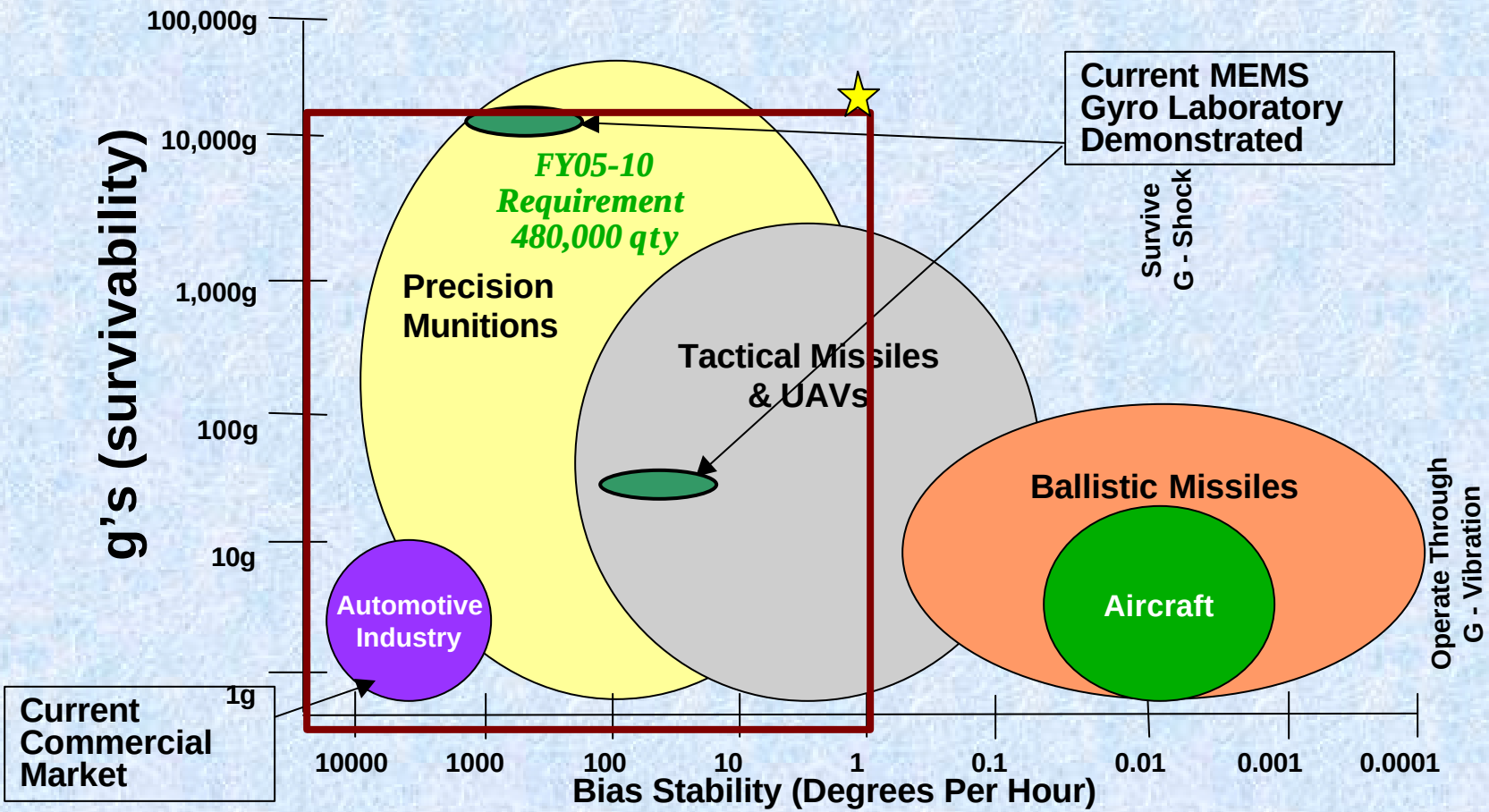
Weight:	*~ 0.5 lbs*
Volume:	*< 3 cu in*
Power:	*< 3 Watt*
Bias Stability:	*1 deg/hr*
Shock:	*20,000g*

Meets Accuracy & Size Needs for >90% DoD Precision Weapons

How CGCS Gets to Affordability



Missiles/Munitions IMU Market



Economy of Scale achieved by capturing >90% DoD needs in precision weapons

Affordability Strategy Enablers

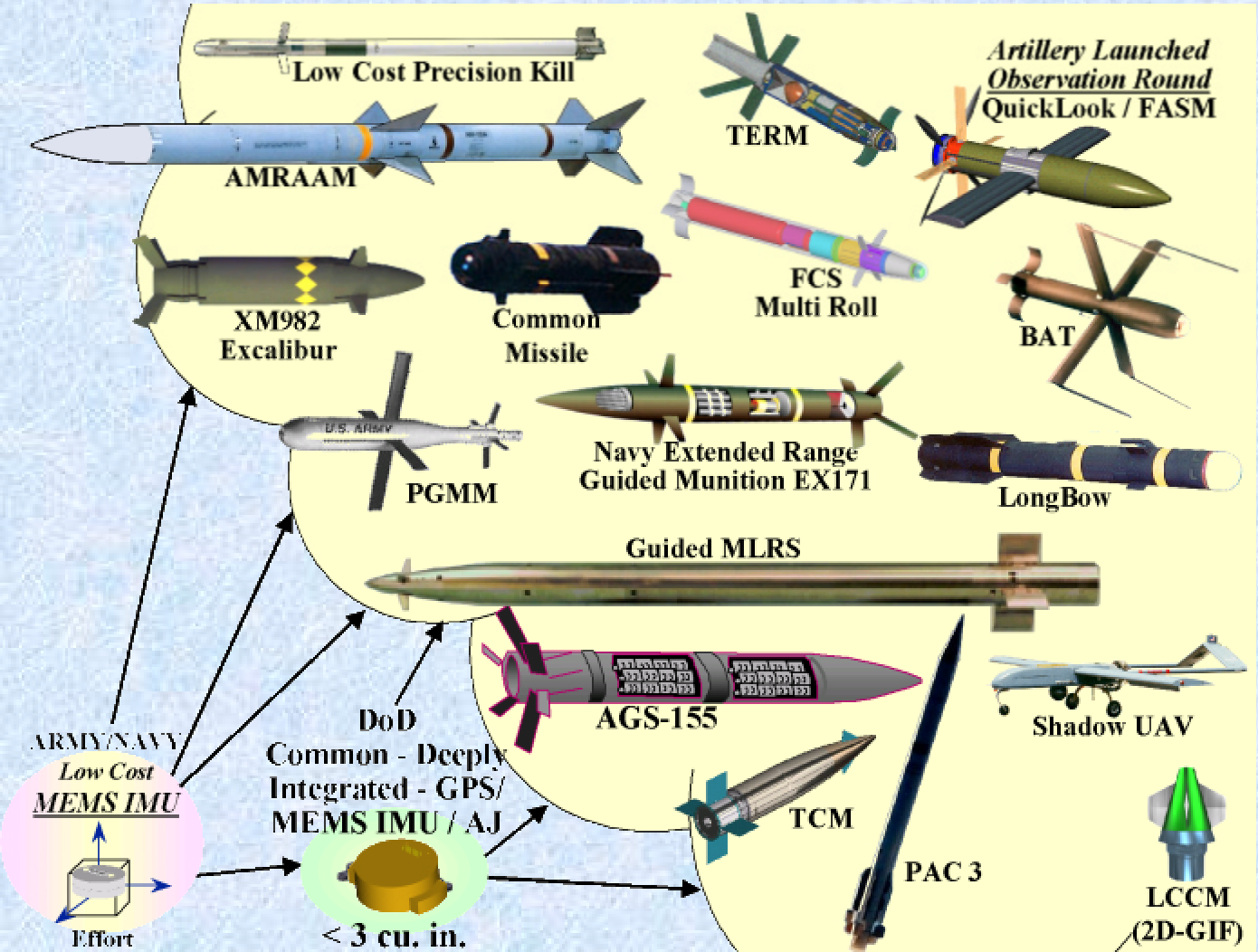
- Joint S&T / MANTECH Management
  - Efficient and Effective
- Economy of Scale / Volume Business Strategy
  - One Common MEMS IMU System for Most DoD Applications
    - Reduces Unit Cost
    - Stabilizes and Extends Production Line Life
    - Reduced Maintenance and Repair Costs
    - Inter-Service interoperability
- Competition
  - Development: Enhances innovation and market stability
  - Production: Further reduces unit cost and improves quality

Goal: - Common MEMS IMU for Most DoD Applications

Low Cost, High-*g*, MEMS, IMU & Common Guidance Coordinated Development and Manufacturing Effort

(aka: Common Guidance – Common Sense (CGCS))

Objective: **Design, Develop and Establish Automated Manufacturing Technologies for Low Cost, Accurate, High-*g* MEMS IMUs and Common GPS/IMU/AJ Guidance for DoD.**



Warfighter Payoffs:

- System Commonality.
- Reduce Cost & Size.
- Increase Lethality.
- Increase Stowed Kills.
- Reduce Logistics.
- Improve Survivability.
- Reduce Collateral Damage.
- Minimize non-combatant casualties.

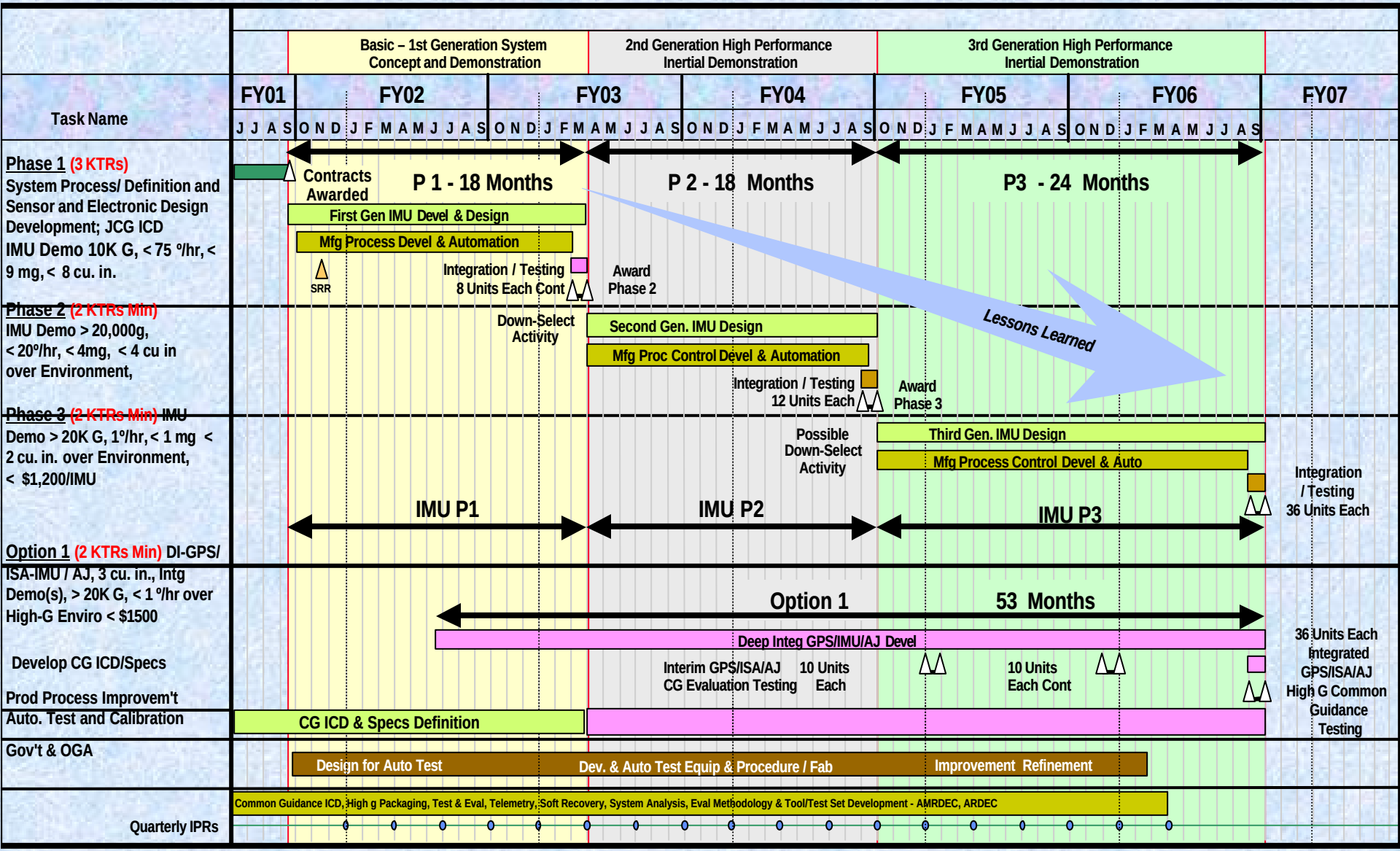
Cost Benefits (FY06-23)

$1,680,000K (Cost Avoidance)

Pacing Technologies:

- **MEMS Inertial Sensors**

High-G, Low Cost, MEMs IMU & Common Guidance Coordinated Development & Manufacturing Effort Schedule (aka: Common Guidance – Common Sense (CGCS))



DTO WE.80 High-*g*, MEMS Inertial Measurement Unit

(aka: Common Guidance – Common Sense (CGCS) Program)

TECHNICAL PROGRESS TOWARDS COMPLETION

Three Teams Awarded Other Transaction Agreements (OTA)

Shotgun Start – All Started on 28 Sep 2001

- **Honeywell/Draper Labs/Rockwell Collins**
- **L3-IEC**
- **Northrop Grumman (Litton)/Raytheon**

All Completed First Quarterly Progress Review

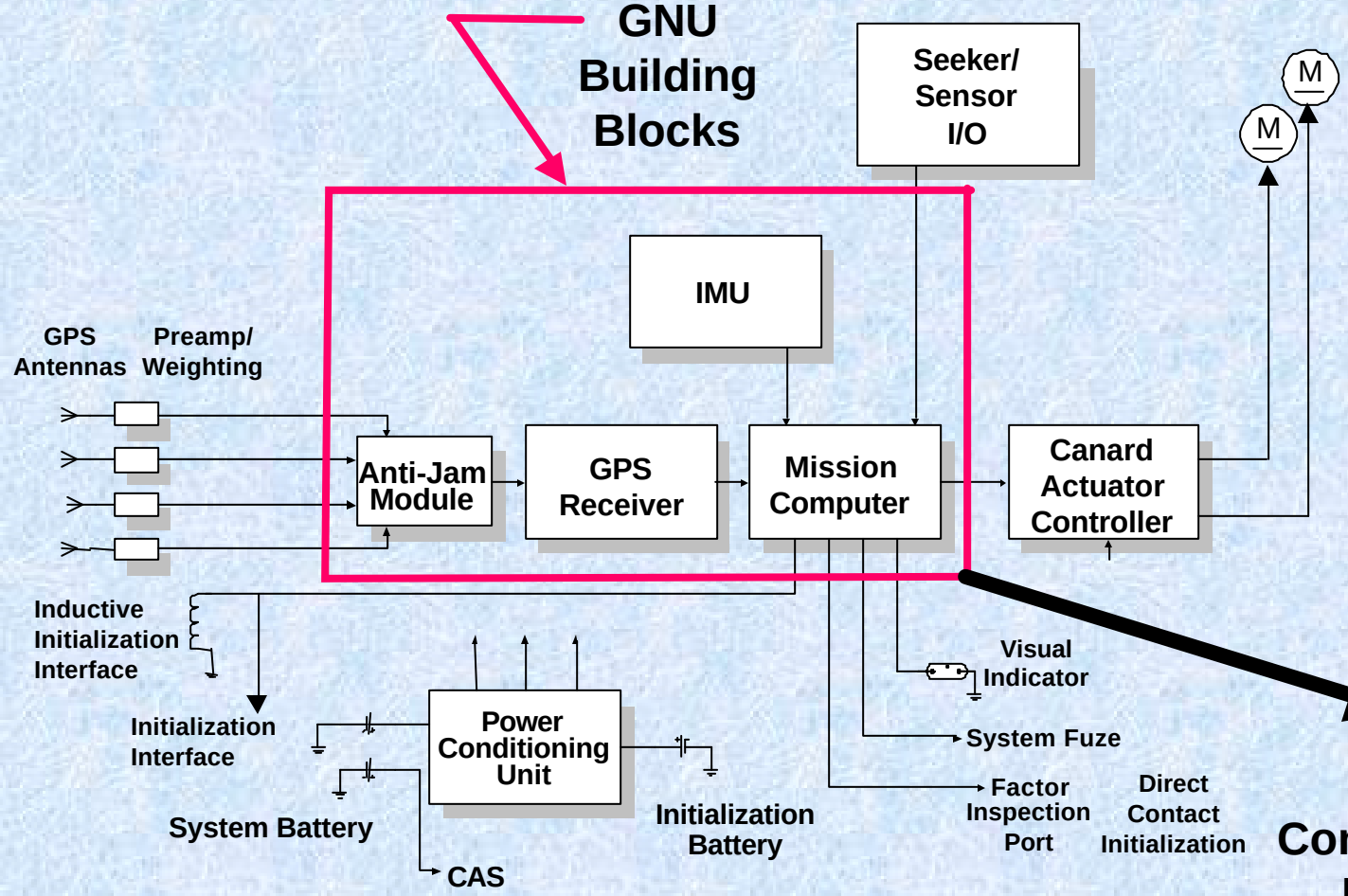
Self-Assessment: Based upon technical approach, funding, and technical progress, this DTO is green.

? - Three awards made, but a downselect to two contractors occurs at conclusion of Phase 1.

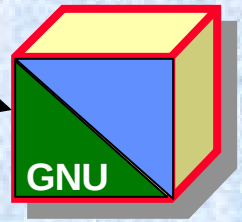
Typical GN&C Functional Block Diagram

COMMON GUIDANCE
COMMON SENSE

Typical As used in: LCPK, XM982, PGMM, GMLRS, LCCM, MRAAS, QuickLook, TERM, MRM, AGS, ERGM, TCM



Building Block of the Future



Common Guidance & Navigation Unit (GNU) Module Single Processor Architecture

Currently, Each Subassembly Represents One or More Circuit Card Assemblies, Each With One or More Processors

Deeply Integrated – Guidance & Navigation Unit (DI-GNU)

DTO WE.80, High-G Micro Electro Mechanical Systems Inertial Measurement Unit

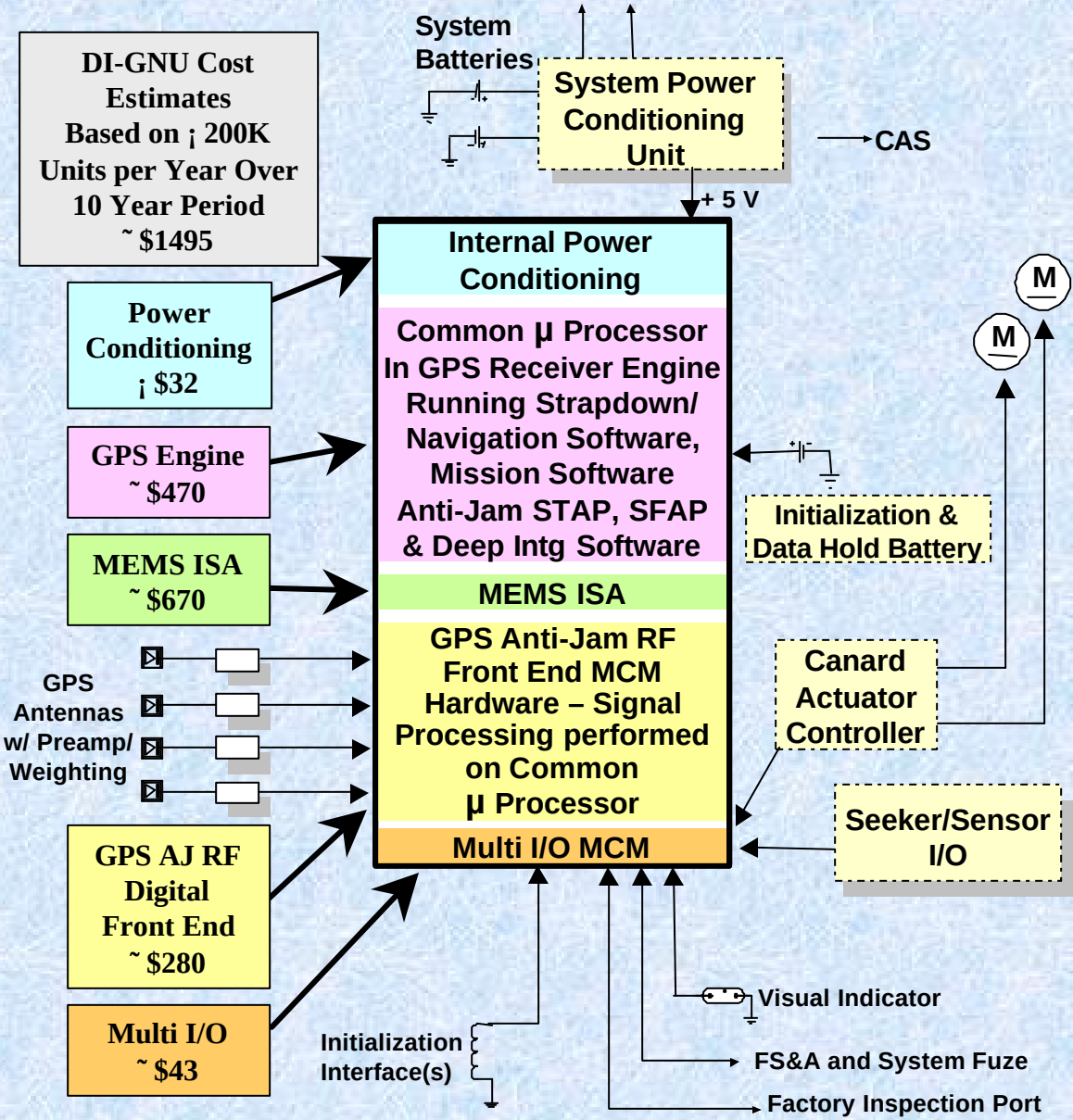
COMMON GUIDANCE
COMMON SENSE

"Common" Deeply Integrated Guidance & Navigation Unit (DI-GNU)

"Common" G&N Interface Control Document (ICD) & System Specification

Hardware Deep Integration Within Single Processor Architecture Reduces Latency Errors

Lower Piece Part Count
Higher Reliability
Higher Production Volume
Multiple Vendors
Economy of Scale
Promotes Competition
Low Cost



Summary

- **Shotgun Start – All Started on 28 Sep 01**
- **Down Selected to Honeywell & L3 – 8 May 02**
- **Affordable, High-G, Accurate MEMS IMUs are required for next generation munitions, missiles and other G&N applications.**
- **The program described has a significant return for the investment across DoD.**
- **The program will develop 2 contractors capable of producing Low Cost MEMs IMU systems at < $1200/unit in production and DI-GNU systems at < $1500/unit in production.**

Program Structure (OTA + Milestone Payment) appears to be working well